An Integrated Investigation of Inner-Shelf Strata on the Eel Margin: The Coarse-Grained Portion of a Transgressive Shelf Sequence

Neal Driscoll

Geology & Geophysics Department
Woods Hole Oceanographic Institution
Woods Hole, MA 02536
phone: (508) 289-2619 fax: (508) 457-2187 email: ndriscoll@whoi.edu

Award #: N00014-00-1-0791
http://www.whoi.edu/science/GG/dept/cv/nwd.html

LONG-TERM GOALS

My long-term goal is to define the completeness of the stratigraphic record along continental margins in response to climate change, tectonics, and eustasy.

OBJECTIVES

My main objectives are to understand the geologic history of the Eel and Mad river dispersal systems and determine how the interplay between physiography, climate change, tectonics, and eustasy governs accommodation and stratal architecture along this actively deforming region. Short-term sediment input, dispersal, and accumulation appear to be predominantly controlled by climate and hydrodynamics, whereas longer-term preservation is, in large part, governed by both tectonically- and eustatically-generated accommodation along the Eel margin.

APPROACH

We acquired approximately 300 nm of Chirp seismic data along the Eel margin to define the spatial variability of the preserved stratigraphy onboard the R/V Thompson in July 2000. 24 dip lines with ~1.5-km spacing were acquired beginning at transect -B in the south and extending to transect V in the north. Three strike lines were also collected to correlate the dip lines and to provide tie points for the seismic grid. This new grid of high-resolution seismic data complements the data acquired during three previous geophysical surveys of the shallow water shelf region (~20 - 70 m). On the basis of the geophysical data, coring stations were selected to ground truth the seismic reflection images.

WORK COMPLETED

Preparations for the R/V Thompson cruise TN113 were completed, including an overhaul to the SUBSCAN system to upgrade many of the circuit boards for increased reliability in the field. Our cruise onboard the R/V Thompson (July 2000) was a success. We collected numerous seismic lines across the Eel Basin coincident with coring stations that provide a geologic framework for the inner shelf. Data processing and analysis of the new geophysical data are underway (Figures 1-3).

RESULTS

Based on seismic interpretations of the 1998 and 1999 Chirp data, we identified the ravinement surface associated with last relative sea level rise across the Eel Basin. By systematically mapping the ravinement surface, we defined regions where the overlying Holocene deposits are thin (~1m) and we sampled the surface at several sites (e.g., site Q45, Figure 1). The surface correlates with a coarse-grained layer of rounded pebbles and cobbles that overlie a fine-grained laminated deposit, which we interpret as the shoreward migration of the beach across the underlying estuarine/lagoonal deposits.

The completeness of the Holocene stratigraphic record varies along strike in the Eel Basin, because the synclines and anticlines trend at high angles to the shoreline. The completeness of the sedimentary record reflects the episodicity of sediment input, as well as reworking and erosion. In the synclines along the Eel Basin, which also control the location of rivers, there is greater sediment input and the depositional events have a greater preservation potential due to rapid subsidence. The Little Salmon Anticline has influenced sediment dispersal and preservation both during lowstands and highstands of sea level, being a drainage divide during lowstands and enhancing reworking and erosion during highstands.

We observed a seaward thinning wedge beneath the ravinement surface on Line S in Chirp data collected onboard the R/V Thompson in 1999. The geometry of this wedge as well as its location suggested it might be an alluvial deposit recording the creation of subaerial accommodation during the last sea level fall. We acquired new Chirp data during the 2000 field season onboard the R/V Thompson that confirmed our initial findings and allowed us to define the distribution and thickness of the seaward thinning wedge. The formation of subaerial accommodation during the last relative sea-level fall would result if the slope of the exposed shelf was less than that of the fluvial system of the coastal mountain ranges. It results in an alluvial wedge deposited along the margin that thins seaward (Figure 2). In addition, the channel width to depth ratio is markedly different for the channels observed offshore California than those observed offshore New Jersey (Figure 3). Note the ravinement surface does not coalesce with the angular unconformity in the interfluv regions for the channels observed offshore California. Both of these observations, together with the seaward thinning alluvial wedge, are consistent with the generation of subaerial accommodation during the last sea level fall and highlight the importance of pre-existing physiography on channel development and incision. Long cores are required to sample the seaward thinning wedge along the margin to determine the environment of deposition.

IMPACT/APPLICATIONS

Geophysical images of the fold and fault structures offshore Northern California has improved our understanding of the tectonic deformation and how it governs long-term accumulation along the margin. Furthermore, understanding how the initial physiography of the margin controls stratal architecture and subaerial/submarine accommodation will allow us to predict channel development and margin morphology along other margin systems in response to perturbations.

TRANSITIONS

Chirp seismic images are providing constraints on the formation of geological structures just beneath the seafloor that might yield acoustic returns along featureless continental shelves, which is the critical first step toward understanding and mitigating ‘false’ acoustic returns (geologic clutter) observed on fleet sonar systems.

RELATED PROJECTS

Field sampling has been a joint effort with Drs. C. Nittrouer (UW) and J. Borgeld (HSU). The goals of this project interface with the objectives of a number of ongoing and proposed research projects within the NSF MARGINS Program.

We are using the ONR SUBSCAN system to map fault systems and shallow-water environments at numerous other locations (CA, SC, NC) in collaboration with the USGS to define the geologic framework for these regions.

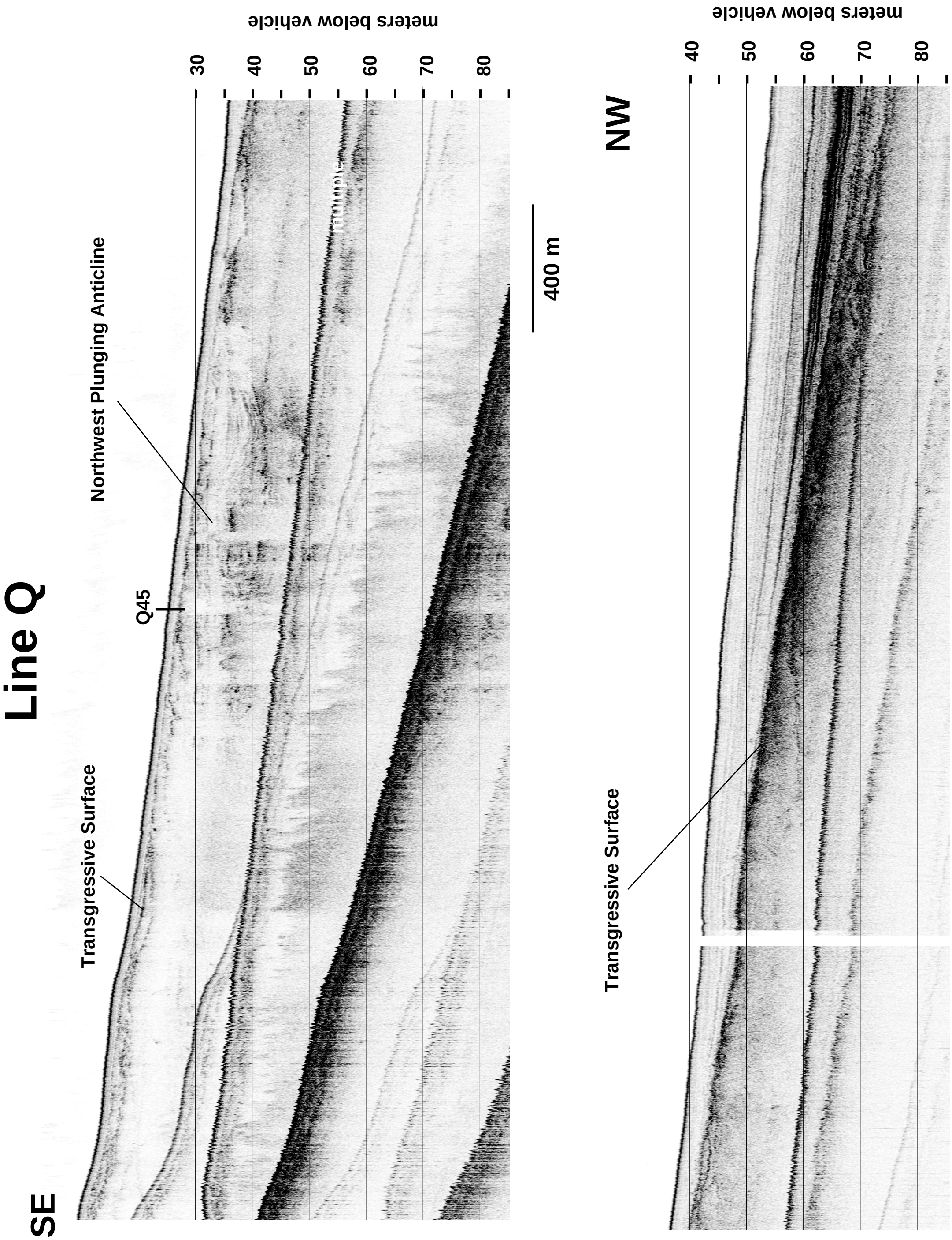


Figure 1. Seismic Line Q collected from the Eel shelf with the newly designed ONR Chirp system. The profile is a dip line that runs almost parallel to the trend of the Little Salmon Anticline. The Holocene transgressive sequence is thin (~1.5 m) over the crest of the anticline. The location of Q45 is shown, which sampled the transgressive surface.

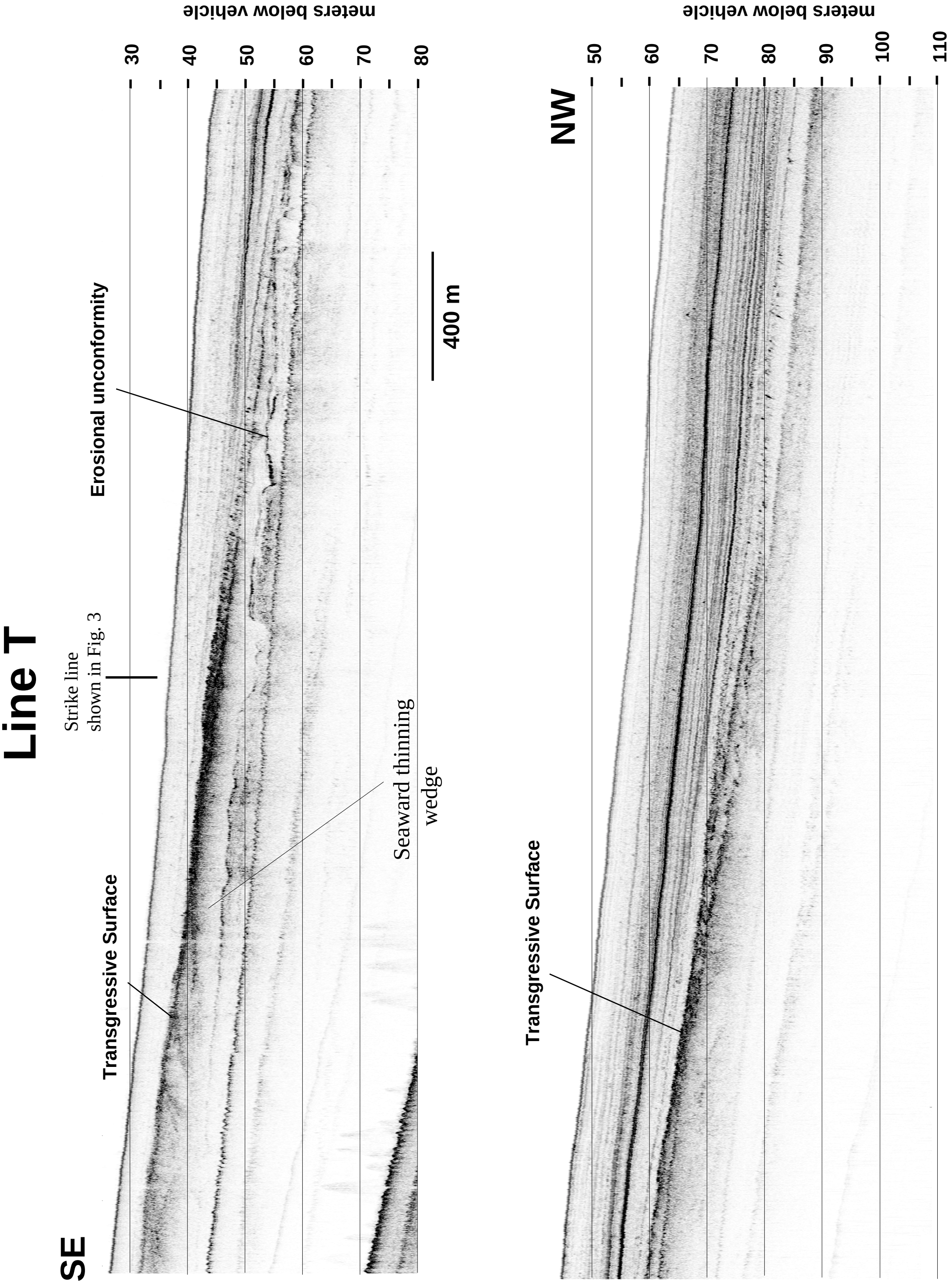
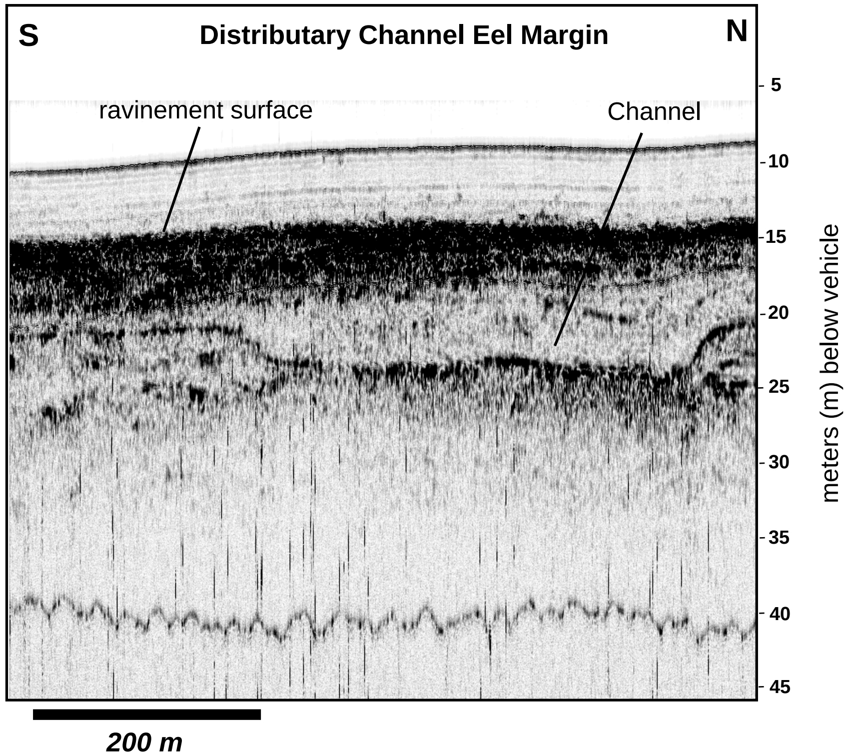


Figure 2. Chirp profile Line T across the Eel Margin shelf illustrating the seaward thinning wedge, which is separated from the onlapping transgressive strata by the ravinement surface. Crossing strike line is shown in Figure 3.



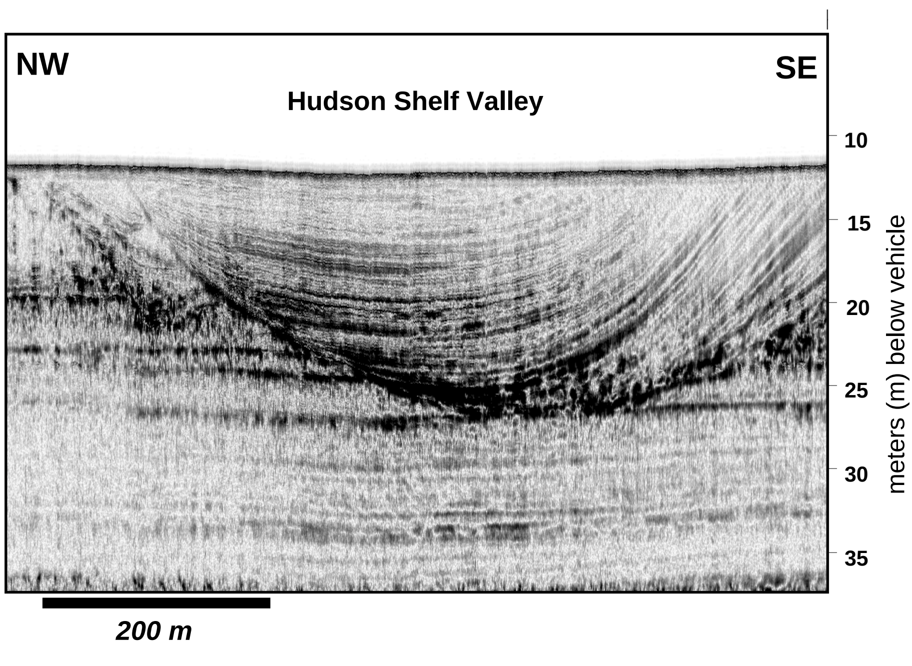


***Figure 3.** Top - A Chirp strikeline across the channel imaged in Line T (Figure 2), offshore California. The channel fill is acoustically transparent and the highly reflective acoustic character of the ravinement surface is suggestive of gas. Bottom - A Chirp seismic image across the Hudson Shelf Valley, offshore New Jersey, acquired with the ONR-funded SUBSCAN system. The channel width to depth ratio is markedly different for the channels observed offshore California than those observed offshore New Jersey. In addition, the ravinement surface does not coalesce with the angular unconformity in the interfluv regions for the channels observed offshore California.*